ARL-SR-0372 ● MAY 2017


US Army Research Laboratory

# Good Practice and Recommendations for Research Team Leadership

by Mark L Bundy

## NOTICES

### Disclaimers

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

ARL-SR-0372 ● MAY 2017

US Army Research Laboratory

# Good Practice and Recommendations for Research Team Leadership

**by Mark L Bundy**
*Vehicle Technology Directorate, ARL*

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE *(DD-MM-YYYY)* | 2. REPORT TYPE | 3. DATES COVERED (From - To) |
|---|---|---|
| May 2017 | Special Report | 1981–2017 |

**4. TITLE AND SUBTITLE**
Good Practice and Recommendations for Research Team Leadership

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**
Mark L Bundy

**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
US Army Research Laboratory
ATTN: RDRL-VTM
Aberdeen Proving Ground, MD 21005-5066

**8. PERFORMING ORGANIZATION REPORT NUMBER**
ARL-SR-0372

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

**10. SPONSOR/MONITOR'S ACRONYM(S)**

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION/AVAILABILITY STATEMENT**
Approved for public release; distribution is unlimited.

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**
Lessons learned from years of research-team leadership experience are enumerated and partitioned into best programmatic and people-skill practices. From a productivity standpoint, people skills are the most important element of a mission-based team lead's job; whereas, for a program-based team, the leader's primary duties are to coordinate lines of communications and plan tasks in preparation for a successful product transition to advanced development. In either case, the roles and requirements of a research team lead are more extensive than understanding the science. They call for understanding and respecting the needs and talents of people, and the operation of the organization at all levels.

**15. SUBJECT TERMS**
research leadership, teams, best practices, recommendations, career guide, motivation

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | Mark L Bundy |
| Unclassified | Unclassified | Unclassified | UU | 26 | 19b. TELEPHONE NUMBER (Include area code) 410-278-4318 |

## Contents

INTENTIONALLY LEFT BLANK.

## 1. Introduction

Research teams are generally formed to conduct the long-term scientific mission of the organization/laboratory. The long-term mission-based research team is composed of individuals with varied academic backgrounds and on-the-job experience. Inevitably, technical challenges change, as do organizational priorities, and there can be a misalignment between new skill-set requirements and legacy backgrounds, which can lead to diminished individual and team research enthusiasm/productivity. The role of the mission-based research team lead is to facilitate and motivate near-term productivity, ensuring that goals are met and accomplishments recognized; however, it is also incumbent on the team lead to work with team members to accommodate/adjust to changing priorities and plan for sustained productivity into the far-term.

There are occasions when teams are created with a short-term focus on a particular high-priority problem. The short-term, program-type research team is composed of senior-level/experienced scientists, each a subject matter expert in their own right; the Lead's role for this team is less of a career guide and more programmatically focused.

In either role, the team lead should ensure, and show by example, that there is always respect for all team member talents and contributions. This report is based upon the accumulated lessons learned and observations by the author in serving approximately 15 years as a bench-level scientist, roughly 10 years as a technical program Lead, and lastly, nearly 10 years as a mission research team lead.

## 2. Mission Versus Program Teams*

In any given year, members of a mission research team are working on varied projects, each with a different hypothesis, objectives and goals (thus, multiple projects) but sharing in common some overall theme (e.g., research areas could include the following: engines, drive-trains, armors, propellants, projectiles, signatures, networks, batteries). Members span a range of backgrounds and on-the-

* The definition here of mission-based (multiproject) versus program-based (single project) research team is not necessarily widely accepted, nor does there appear to be any widely accepted classifications, especially in the specialized area of research teams. At best, reference can be found in the literature to the general categories of "organizational or functional teams" composed of "independent" team members doing the mission of the organization (analogous to our mission team), and "project teams" composed of members that are "interdependent" on each other to accomplishing the goals of the project (analogous to our program team). The classifications of research teams here are only for the purpose of understanding the rationale and recommendations for the best leadership practices in each type of team.

job experience and often remain on the team for their entire career. The team itself usually exists as long as the overarching organizational structure is stable.

The program research team is formed to specifically focus on one particular research topic or technology that is either urgently needed or recently discovered (e.g., detection or response to a new threat, or applications for a new manufacturing process or material). The duration of the team is of finite length, lasting until the particular problem under study is either solved, advanced, or further research is deferred, and the team dissolved. Accordingly, membership in a program research team is temporary, but all members share in common the same overall program objective and impact on the Army. Unlike a mission research team, a program research team is "hand-picked" and usually composed of senior research scientists and subject matter experts from inside or outside the organization, often unfamiliar with one another. Because these 2 teams are so different in their makeup, duration, and objectives, best practices and recommendations for leading these 2 types of teams will be discussed separately.

# 3. Good Team-Lead Practice

Team leadership requires both people skills and organizational/programmatic skills, the former are more nuanced, and the latter more easily defined/enumerated. For expediency, the programmatic responsibilities are discussed first.

## 3.1 Programmatic

### 3.1.1 Mission Research Team

A mission-based research team lead provides the technical bridge between the "bench level" scientists and the strategic planners and trackers that are the supervisors and the spokespersons for the laboratory. Typically, this information pass-through is done at a bottom-line upfront (BLUF) level through regularly scheduled or informal review meetings, summary-level activity reports, and on occasion, a face-to-face, in-depth, team-member-to-management briefing. It behooves the team lead to ensure that supervisors and spokespersons are kept current and accurate in their understanding of the research under their purview—if this is not nurtured, the team can be found in the awkward position of defending research positions proffered by "management" that may be invalid or unattainable.

Teams are distinguished (beyond their name) by their research focus; it is good practice for the team lead to fashion a team mission statement. That statement should be refined enough to capture the subject matter expertise of team members and describe how that expertise is used to mitigate Army problems. That said, the

mission statement should also be general enough to give team members latitude to conduct research in areas on the margins of their specialty. The latter is not to be overlooked because it is the latter margins, the grey mission areas, where the most innovative work often begins. Although the opportunity, or need to provide the team mission statement does not present itself often, situations can arise where having a BLUF Scope of Work/Expertise (SoW/E) statement for the team can be useful in conveying, on a high level, the research specialty of the team and its members. It can also be helpful, if needed, to justify or defend questions as to why a particular research topic should be considered part of the team mission. It is also a good practice to periodically review/update this statement, as neither team membership, expertise, nor the Army problems they work on are immutable.

In addition to the mission statement, it is recommended that the team lead should have at the ready a high-level research roadmap for team projects. Emphasizing—this roadmap should be created with, not isolated from team member input. The roadmap should convey the active problems being investigated and delineate the goals and major milestones of team projects (having in hand, a knowledge of the metrics that will be used to judge whether the goals were successfully met or not). The (multi-) project roadmap should also show how each project fits into the larger strategic mission of the Army's/organization's programs and priorities. The importance of the later practice should not be overlooked. For instance, a recent review of US Army Research Laboratory (ARL) research (2015–2016) by the National Academies of Sciences noted that although the research was top quality, often ARL researchers did not convey how their research project supported the overarching Laboratory and Army objectives and challenges.[1]

Backing up the roadmap, the team lead should ask each team-member-led project to create and maintain a detailed project description, containing the following: motivation for solving the problem, current knowledge/state-of-art (SoA), unresolved challenges, the novelty of the current solution approach, partners, milestones and metrics for measuring success, progress to date, and who is aware of (publications, meetings) and maintaining interest in the solution. Supervisors will also want to know the team's budget requirements for acquiring the necessary hardware and software tools that will enable the team to accomplish their stated goals. Typically, the budget will not allow all requests to be met and the list should be prioritized accordingly.

With regard to the day-to-day science that takes place within the team, it is a good practice to schedule a time and place (weekly, biweekly, perhaps monthly) for in-depth team discussion of each member's individual project, and the status thereof. Why? Because this gives each researcher the opportunity to formulate the rationale/explanation for why they are approaching their research problem the way

they are, and it gives other team members the chance to challenge, gain insight, or offer suggestions to the approach being taken on the project by their teammate. The process of explaining why something is being done can 1) uncover/reveal logical omissions, 2) solidify one's own understanding of the problem, and 3) bring clarity to how the research is best conveyed to others. There are also numerous times when team members are asked to be spokespersons for (typically in the absence of) their fellow teammates. In those instances, a shared understanding of what each other is engaged in, supports the networking of technical information throughout the organization.

In summary, programmatic requirements for a mission-based research team would include the following:

- A team-encompassing research mission statement.
- A team-encompassing research roadmap (with goals, and general milestones for each project and an indication of how the project impacts the broader Army objectives).
- Project-lead-maintained, in-depth, project overviews (motivation/goals, SoA, challenges, approach, metrics, status, cognizants).
- A team budget (equipment, training, travel requirements).
- Periodic, within-team research updates/informal presentations by and to fellow team members.

These are good team "business" practices. Having programmatic research documentation and distributed project knowledge available will provide the team lead (and when needed, the acting team lead) with clarity and serve as a foundation for rapid response to organization-driven "taskers" for project updates and status reports.

### 3.1.2 Program Research Team

Unlike the mission research team, which is budgeted for the long term, the program research team is created and funded for a finite length of time. It can be funded in-house, or it can be (customer-) funded by an out-of-house agency whose mission is to provide support for solutions in a designated problem area. In either case, the funding lines are typically time-limited.

Usually, the program team lead is the person that is the most knowledgeable of or influential in developing the technical aspects/plans for the research program, but in some instances that person is appointed to the Lead position. Regardless, the Lead has substantial input in selecting the team members based on the expertise

they bring to solving the singular research problem at hand. It is especially true of customer-funded programs that the expertise of the team members is explicitly called out in the (winning) proposal, but there are some team positions, regardless of the problem under study, that can be advantageous to every program, as will be explained.

The standard Army protocol for transitioning successful research from the lab-scale (e.g., prototype demonstration) to the field is to establish a transition partner within the appropriate Research Development and Engineering Center (RDEC), where scaled-up development and engineering issues are addressed. This partnership can be formal (e.g., through a Technical Program Agreement [TPA]), or informal (e.g., having an RDEC advisory member on the program team), or both. In addition, transitioning research from the lab to an RDEC is predicated upon a formal/document that spells out the need for Army implementation of the problem solution. This need statement is identified and generated within the US Army's Training and Doctrine Command (TRADOC). Finally, funding is the lifeblood of product implementation. It is not enough to have a TRADOC need/requirement statement and an RDEC transitioning partner, large-scale development and product maintenance is a long-term process that is financially managed by a Program Management (PM) office. The PM office needs to be aware—far in advance—of the projected timeline for field implementation and the projected funding requirement for full-scale development and sustainment. Hence, a well-balanced program research team should have members from, or representation at, RDEC, TRADOC, and the PM offices.

In practice, a program team lead is not regularly asked by their immediate supervisor to report on the status of the program. Most likely this is because a program is often funded by an authority higher than the Lead's immediate supervisor, perhaps by the laboratory Director, or some outside customer. Nevertheless, it is a good business practice for the program Lead to take the initiative in publicizing the program's progress in- and out-of-house because it keeps the program and its value-added objectives exposed. Exposure invites questions, questions stimulate answers, and answers are either already on hand, or just as valuable, brought to light for pursuit and resolution. Eventually, the community of interest will be knowledgeable of the response to virtually any and all questions, technical, implemental, or financial. The value in this knowledge is that it makes it highly unlikely that surprises, "show-stoppers", will derail the research and its implementation. Moreover, transitioning research from the bench level to the field is a multi-year process, long enough that the initial commanders/decision-makers who are familiar/supportive of the research program may move on to other assignments and their replacements need to be convinced

anew of the research program's value. Having answers to all the likely questions that will (once-again) be asked by a new "regime" will help ensure the continuity of support, regardless of changes in command.

Depending on the program size, program management may best be accomplished by subdividing the program into sub-teams, each responsible for specialized area in the program. As aforementioned, the business side of program management focuses on dissemination and promotion of the program and securing financial stability. Such a business sub-team is strengthened if it includes members from TRADOC and the PM office. There is obviously an execution side of the research program. For example, the problem solution may require hardware or software development, which is generally in the realm of mechanical or computer engineering. Evidence-based outcomes, reliability, and safety certification through testing is a mandatory aspect of product development: this could engage the Army test centers or RDECs. Testing conclusions invariably require a statistical analysis of the results, commonly an area-specialty of mathematicians. If appropriate, choosing subject matter experts from inside or outside the lab to fill these specialized execution sub-teams is a good-practice and a responsibility of the research program team lead. In addition, each of the various sub-teams should be tasked with having a roadmap with milestones and metrics for the successful completion of their portion of the larger program effort.

Since laboratory research programs are typically funded for 3 years, and field implementation my take 3 times that amount of time to complete, the question may be asked, "are there pitfalls in dissolving the original research team after transitioning the technology to an RDEC?" Yes! Although it is recommended to have RDEC involvement on the research team from its inception, inevitably, problems arise in the mid-term RDEC-development years where the intimate knowledge acquired by the original (early development) research team can be a critical asset in resolving the problem. It therefore behooves the program research team lead to advocate, in advance (to the PM office for example) for technology-transition funding, at least at some level, to ensure that the fledgling advanced development effort has research team support if needed. Maintaining a good relationship with TRADOC throughout the program team's research campaign can be useful in making the case to the PM that some level of continued research team funding during the mid-development, technology-transition years is a good investment.

In summary, and in brief, good programmatic practices for leading a program research team include the following:

- Network and partner from the outset with the RDECs, TRADOC, and the PM office.
- If appropriate, divide the team into a business side, which broadly disseminates the program's progress, welcomes questions and seeks answers, and an execution side, which may be many-faceted and led by subject matter experts knowledgeable and experienced in each facet. All distinct sub-teams of the program should have a plan of execution.
- As a contingency plan for what are likely to be some residual research-team-related problems during the mid-development period of the RDEC-led technology transition, advocate for some level of follow-on funding, from the PM for example, for continued research support during the advanced development phase.

## 3.2 People Skills

What are the qualities needed to be a (nonsupervisory) research team lead? More specifically, what are the people skills needed to be a good leader? First and foremost, a good leader should be acknowledged as deserving of that description by the team members they lead. Good practices for leading a diverse group of people can vary somewhat depending on the team SoW/E. In particular, practices for leading a mission versus a program research team are different, with the former having members with a range of on-the-job experience, and the latter heavily weighted with experienced senior researchers who need far less guidance.

### 3.2.1 Mission Research Team

Recall, a mission research team is composed of members who typically serve for a long period of time (e.g., until retirement) and collectively investigate a range of problems (all are within the scope of the mission statement) with near-, mid-, and far-term payoff. For this group, the team lead should provide 1) support and recognition for senior researchers, 2) advice and perspective for junior (or mid-career) researchers, and 3) guidance and constructive technical feedback, especially on publications and presentations, for young (early-career) researchers. At all levels, the team lead should be aware of and provide constructive advice to help advance the career of team members, individualized according to each member's long-range career vision for themselves.

First, how does a senior team member feel supported by the team lead? Support is conveyed by appreciating the senior member's research contributions and acknowledging their successes; this means staying cognizant of, moreover, inquisitive about the subject matter that is a senior team member's research. If the

opportunity and need arises, such knowledge can be used to advocate to supervisors and peers why the senior team member's research is of value to the Army. Team leads have the opportunity to instantiate recognition of senior team members by nominating deserving members for research awards and promotion. A successful nomination requires the team lead to understand the research and make knowledgeable, compelling arguments/justifications for the worthiness of the nomine. If the nomination is for an award, the team lead's responsibility is to write an award citation that is technically accurate (the pride an awardee feels when accepting an award can vanish when a flawed citation is given as justification for the award).

If the team lead is recommending a senior team member for promotion, there must be substantial forethought and preparation invested in the nomination documentation. For a senior member, the level of justification can require clear evidence that the researcher's work is nationally recognized, either in the scientific (basic research) or military-systems (applied research) community at large. Building this level of stature takes time, but provided the work is of sufficient caliber, the team lead helps the senior member build their resume by encouraging them to document their research in journals, conference proceedings, and laboratory reports, as well as present their work at professional society meetings, and/or government workshops and major command-level visits. Furthermore, the team lead should encourage senior members to join government and professional society panels where their expertise and opinions are valued and relied upon.

In some instances, the senior member may be eligible for, have an interest in, and could best serve the organization by taking a temporary assignment detail. Such assignments can be attractive to the senior researcher as they provide an opportunity for their acquired knowledge to be influential in guiding programmatic decision-makers at higher organizational levels. Developmental assignments may be valued by the senior research as a way to acquire management skills, setting up opportunities for them to guide the organization's mission programs as a supervisor-in-training. Perhaps a senior member wants to share his wealth of experience through a developmental teaching assignment at an outside institution. All of these temporary assignments show the senior member that they are a valued member of not only the team, but the organization; they also build the reputation and breadth of experience that is looked upon favorably by promotion evaluation committees.

All in all, senior team members are (or should be) the easiest to lead, as these members are generally the team lead's peers in terms of experience, and the pool from which the acting team lead is drawn, when needed. Senior members can be

relied upon to accomplish the mission efficiently and expeditiously; moreover, they directly or indirectly mentor junior and freshmen team members, if only by example.

What advice and perspective do junior researchers most often need? Junior researchers should learn how to network within the organization. One way a team lead can teach networking skills is by demonstrating them firsthand; when an opportunity presents itself, and in the presence of junior team members, the team lead can set up meetings/visits/phone calls to people and places where resources are available. Once in these settings, the Lead can demonstrate (or reaffirm) how to conduct oneself in a networking-affable manner, including the following: acknowledging the expertise and experience of the hosts; coming prepared with specific inquiries/agenda; not overextend the visit beyond the intended purpose; and based on real-time feedback, show good judgment in any requests for further assistance. Lastly, follow up with a brief message of thanks to the host, perhaps the next day. Exposure of these subtle but useful mannerisms to junior researchers will help them grow and maintain their own organizational network in the future.

In many instances, the junior researcher career is one that follows the path of becoming very proficient in the specialty for which they were hired, but this specialty may be time-limited with regard to addressing evolving Army challenges. If this is the case, the researcher and the team lead are usually in agreement on the shift in Army focus, which makes the junior researcher receptive to branching out. Again, one avenue that facilitates expanding their skill set is the assignment detail. There are several temporary assignments appropriate for broadening a junior member's horizons. One is to become a temporary programmatic assistant to a senior manager. In such positions, they can observe the range of research activities across a multitude of teams within the organization and learn how, why and where, the organizational priorities originate. The junior researcher may also learn to expand their competencies by temporarily becoming an adjunct member of another team in the organization. Of course, the team lead can also facilitate expanding the team members skill set through formal course work that addresses a need within the team's mission profile (SoW). For junior team members, promotion qualifications center around the quality of work as recognized in-house (i.e., within the laboratory itself). The team lead can assist in getting the junior member's work the necessary in-house exposure by encourage them to document their work (papers and reports) and present it to their peers and managers, for example, during laboratory reviews and visiting group tours. Moreover, the team lead's role is to ensure that the junior member's presentations (written and oral) are consistent with professional standards; unfortunately, more lasting-impression-damage can be done with one flawed outing than multiple well-done presentations.

It is nearly universally true that young researchers, even junior team members, need practice at proficient writing. Scientific writing is not unlike other genres in that first and foremost, a technical report, presentation or proposal, is fundamentally a story-telling exercise, albeit a research story. It is specialized, however, in that it requires an upfront explanation of what problem motivates the underlying research, what solutions have been tried in the past, the logic/novelty of the approach taken in the work at hand, the results and conclusions, and a bit of "flavor" can be added by sharing with the audience any surprises, difficulties, or lessons learned along the way. A good team leader should remind junior researchers to reference their background statements, rather than just proclaiming them as facts; include examples and "for instances" to keep the reader correctly oriented; and keep the flow of information (the "story") in a logical order, whether historical or pedagogical. The later criticism is a prevalent problem with junior-level authors, and it is not the job, nor the skill set of a grammatical editor to keep the flow of technical information in logical order. If seasoned senior team members are not available to technically review junior-level reports, then the team leader should make it a priority to fill this role. The team lead is successful if junior researchers learn that proficient writing is a matter of multiple self-reviews and rewrites before their report is ready to be reviewed by others. Learning to be a good writer is something that is measured on the scale of years, so team leaders must be patient but persistent in maintaining high standards.

The previously mentioned good-writing principles and advice are general guidelines, but it is the team leader's responsibility to ensure, through the technical review process, that the scientific reputation of the team member, and that of the organization, is not jeopardized by poorly written or constructed documents. There are 2 teaching objectives to keep in mind when providing a technical review. The first objective is to raise any specific technical questions that need to be resolved; the second objective relates to reinforcing a "story-telling" mindset, the lapse of which, is often the underlying cause for the question or confusion that belies the reviewer's comment. Regardless, both objectives can be dealt with by phrasing a review comment/question to the author from the perspective of a misguided reader, citing examples of how a reader could form/draw/acquire multiple, but mutually incompatible, interpretations as a result of unclear, under-defined, under-developed, or under-thought statements. For instance, pose the review comment by asking whether the author means "this or that" from the questionable statement at hand. Phrasing review comments in this fashion gives the author an understanding of what, why, and how modifications are needed, and takes away any inclination for reviewer comments to be taken as a personal attack by the reviewer on the author.

As for recognition, young researchers are just as deserving of awards as their senior counterparts. It is perhaps more common for young researchers to be part of a group award, as they learn the skill of their research trade from the mentors around them. As for promoting the young researcher, it is the opinion of the author that a young researcher attains the unofficial status of "junior researcher" naturally over time, at which point their portfolio of individual accomplishments will stand on its own merit as worthy of nomination for promotion.

In summary, the following are people skills that serve a successful mission research team lead:

- Stay knowledgeable of senior team member research: engage them with technical questions, inquire as to their level of satisfaction with their research progress, show them that you appreciate their technical expertise (e.g., awards), and encourage them to engage in broader advisor-roles outside the team.
- Serve as a career guide, a sounding board, and network facilitator for junior team members
- Effectively cultivate and develop in junior and young professionals the standards that are expected of them in their collegial associations and in their technical writing and presentation skills.

### 3.2.2 Program Research Team

As aforementioned, a program-based research team is not likely to have junior or young researchers; however, it is common to have "hand-picked" senior-level scientists, frequently from different teams inside and even outside the organization. Thus, a program team lead's time is not so much devoted to mentoring and acting as a "career guide", as it is to addressing the many organizational demands that are not as frequently needed in leading a mission research team. However, exercising people skills that show deference to, respect for, and confidence in the team's senior subject matter experts remain essential.

Since a program research team is brought together, often from different organizations, and stays together for only a finite time, the interpersonal relationships and shared history that exists in a mission research team are not there from the onset. Developing a sense of teamwork, familiarity, and respect among the members is aided by bringing the team together (more frequently at the outset) with each member given the opportunity to present their contribution to the problem solution. These intra-team meetings are forums for the first question-and-answer sessions, valuable as such, but also help in opening up the lines of communications

and breaking down unfamiliarity between the newly formed program team members. The program team lead can set by example, or interject as needed, the decorum for questions that are most effective for a group of individuals that are each subject matter experts in their own fields.

As individual researchers, the program team members have typically been successful (which is the basis for their selection) in their respective research projects but may have lacked the reward that comes with being part of a larger team accomplishment. One that transitions from the small scale, concept demonstration phase to a broader scale, culminating in a fielded product. The program team lead can cultivate this sense of team accomplishment by organizing annual program reviews for upper management at the laboratory, RDEC, TRADOC, and PM level or other involved Department of Defense (DOD) agencies, where each team member has the opportunity to see/feel recognition and appreciation from upper management and policy makers for their combined program effort. If successful, the program can be nominated by the Lead for a program-level award, either within the laboratory (e.g., Honorary Awards) or outside the laboratory—sponsored by the Army (e.g. the Research and Development Achievement Awards), or the DOD at large.

In summary, salient people skills needed for a program team lead include the following:

- Establish and lead intrateam meetings to cultivate effective communications between team members from diverse organizations and specialized areas of expertise.
- Instantiate annual program reviews, preferably offsite, to upper management inside and outside the laboratory to showcase program progress and accomplishments, building the sense of broad outside appreciation for teamwork (as opposed to individual) accomplishments.
- If successful, consider nominating the group for an eligible laboratory, Army, or DOD award, or perhaps patent(s).

### 3.2.3 Motivating Team Members

Steve Wozniak, the co-founder of Apple Computers, was quoted recently as saying[2]: "More important than learning, more important than knowledge, is motivation." Numerous other scholars have made similar proclamations. Clarke[3] reminds us that in accordance with Maslow's hierarchy of needs,[4] "motivation is personal:" some are self-motivated by the challenges of research, others are motivated by peer recognition, and still others are motivated by the impact that

success would have on their promotional potential. Maslow places self-fulfillment (self-motivation) at the pinnacle of motivation.

Is it easy to motivate people? Certainly the financial gain and peer recognition that comes with a promotion is a motivator, but many studies have concluded that in the world of science, financial gain is not a substantial motivator.[3,5] In the world of research, problem solving is a creative process, fueled by a passion for and a persistence to understand and find answers to technical problems. This intrinsic driving force behind scientists and engineers is most-aptly described by a former team member and student contractor, who recently wrote (after a long lapse in correspondence, furthering his education): "I love robotics and research, and I can't imagine another career that would make me happier. I now seek information not because I want a degree or a well-paying job, but because I see it as a tool to help me solve problems. Man has it been rewarding."

The research team lead, and management in general, can create/nurture a motivating environment in the following ways:

- Encourage
- Trust
- Pay attention to the level of passion (or lack thereof) that team members have for their work, especially if the work was assigned, rather than originating from self-discovery.
- Expedite project-dependent actions that require team lead input.
- Promote the participation of team members in research forums (e.g., peer-to-peer conferences, workshops), and expose team members to direct contact with soldier-need spokespersons (at the depots, RDECs, and PM offices).

While elaborating on these practices, is there any doubt that encouragement is a motivator? Recall an instance where a research success was made without so much as a "good work" uttered by leadership. Researchers do not expect awards, they do appreciate recognition of their accomplishments, even if routine—the feeling of being unappreciated or taken for granted is counterproductive. Substantiating this view, a 2006 survey of government scientists in the United Kingdom similarly found that "lack of feedback or recognition of achievements from management emerged as a major factor in de-motivating staff".[5]

Showing someone that their judgement is trusted motivates them to demonstrate that such trust is warranted. Of course, the most convincing evidence of this is firsthand experience, but numerous studies assert this as a consequential reaction.

For instance, the referenced report by Clarke, on *Management and Leadership of Scientists*, advises the following: "To motivate staff, the manager must reinforce the employee's belief that he/she can successfully carry out a difficult project." Conversely, Clarke states that signaling a lack of trust by "insisting all decisions must be cleared through [a] supervisor", is a demotivating factor. This is not to say, avoid questioning assumptions, plans and conclusions; on the contrary, the virtues of such discussions are numerous, as annotated in the People Skills sections (3.2.1-2). Moreover, the concluding slide in a recent presentation given by our own ARL Director, Dr Preconti, entitled *Strategic Overview*,[6] was a simple quote from Stephen R Covey: "Trust is the highest form of human motivation. It brings out the very best in people. But it takes time and patience."

In general researchers are independent thinkers; the hallmark of the PhD degree is the ability to uncover and solve problems independent of external guidance. Hence, by nature and training, senior researchers are well suited to accomplish the ARL motto: "discover, innovate, transition" (knowledge products). Studies have shown (e.g., Jindal-Snape and Snape[5]) that "the perception of autonomy (independence) predicts the energy (motivation) with which individuals pursue a goal". Unfortunately, when the "top down" actions of laboratory management results in the reassigning/reallocating of intellectual/people assets (so-called "critical mass") from one area of research to another, it is seldom interpreted by the reassigned (nor is it the motivation of management) as a "show of trust" in the skills and abilities of the affected individuals. On the contrary, it can, and often does have a demotivating effect. For instance, when an established subject matter expert in a particular area is tasked by management to refocus their scientific intellect in a new research area, especially one that is relatively unfamiliar to the researcher, they are essentially asking that scientist to move down the learning curve, where their stature and research output in the new community of experts is reduced. Furthermore, it is not unusual for top-down-driven (perhaps fanciful), versus research-driven, investigative refocus to be opportunity-limited by unrealistic expectations for advancement in the state of art. On the other hand, if new research comes about naturally, from self-discovery and innovation, then the new research area is by definition at the leading edge, and publishability will exist from the outset on the new learning curve. In concurrence, the report by Clarke[3] summarizes the findings of several studies on the subject of *Managerial Actions to Promote Productivity and Creativity* (in scientists), they include the following: "freedom to follow up on ideas, freedom to change research direction when necessary, freedom to work on areas of greatest interest, freedom to follow projects from the idea stage to the finished product, and freedom to pursue, without penalty, ideas that do not have official approval."

Thus, the top-down managerial belief that assigning more scientists to a problem will expedite its resolution, fails to appreciate that scientists are not widget makers, the level of innovation is not proportional to the number of scientists working on the problem, or how well they get paid. Creative solutions are strongly influenced by motivation and expertise. Team leads are not usually part of the laboratory's research prioritization (down-selection) process; nevertheless, they can play a role in being perceptive to the level of interest/passion team members have for their research (assigned, reassigned, or self-chosen). They can also assess whether the Army's problems (technical gaps and challenges) are trending away from existing team expertise and capabilities. If so, the team lead should help to construct a plan for adapting to evolving challenges through individual training and/or the acquisition of new tools (research hardware or software).

The aforementioned UK survey and Clarke's review paper both affirm that maintaining up-to-date equipment (hardware and software) is a substantial enabler and motivator for scientists to stay at the forefront in their field. There are many instances where a team lead's expeditious (or lack thereof) approval, signature, or communicative assistance can impact the progress on a research project. Unnecessary delays in responsiveness on the part of leadership signals a lack of interest in the research, and by extension the researcher, this is an under-recognized de-motivating factor. Numerous publications make the point: a delayed response from leadership is demotivating.[7–11]

Lastly, the benefits of peer recognition of a researcher's work is highly motivational—ask most researchers what they take away from presenting their work to their peers at a scientific conference; the response will likely be that they are incentivized by the recognition they receive for their accomplishments, their ingenuity, their creativity. They will return to work invigorated and inspired to continue their research, looking forward to the next opportunity to showcase their achievements. Equally motivating is the enthusiasm that is gained by having a Soldier, or a Soldier spokesperson from the field, the maintenance depot, the component developers at the RDECs, or the system protagonists at the PM offices ask for a researcher's help to find a better solution to a Soldier hardware/software problem. As in all the earlier motivation-related discussions, firsthand experience, good and bad, is the best teacher, but the motivational incentive derived from face-to-face encounters with those looking for solutions is universal and well documented in the literature. For example, Grant[12] expresses these sentiments by saying, "When employees have contact with end users, they can see how their work makes a difference in end users' lives, developing a stronger concern for helping them (prosocial motivation) and gaining a deeper understanding of their preferences and viewpoints (perspective-taking). This may motivate them to work

harder and smarter, and more effectively. … To foster creativity, it is not enough to make work interesting, challenging, and engaging. We also need to develop policies and practices that enable employees to understand the impact of their work on past, current, and potential end users."

## 4. Conclusion

Leadership is not a science, nor is leading a scientific research team a requirement for an advanced technical degree (although some advocate that it should[3]). Most researchers become a team lead by virtue of their individual scientific acumen; for some, this transition is a natural fit, for others, they may grow into the job with the experience it brings them (including the good and bad leadership history they may have experienced). This report highlights the lessons learned in team leadership by the decades-long experience of the author. The recommended good practices are both programmatic and people-skill in nature. The advice is further differentiated as appropriate to a mission versus a program type research team. If asked to identify the most important good practice for team leadership, it would be taking an interest in people, not just your immediate research team members (as enumerated earlier); but look to acknowledge those you work with, regardless of their work-related connectedness to you. Even if it's just a "named" hello, it affirms a recognition and appreciation for their presence. Feeling and demonstrating goodwill returns good will, and the people you work with would not be there if they were not helping you and your team to do their job in any number of small or large ways. Others agree. In a review of "lab-leader" good-practices by Di Salvo, she states, "The first thing to remember, according to successful lab managers, is that people are the heart of the lab. Making it work at its best requires being sensitive to the people who work there."[13] A signature institutional program in our own lab, ARL's "People First" initiative, upholds these values.[14] Finally, it would be disingenuous to imply that all the recommended good practices, though experienced and recognized firsthand, are, once-learned, always followed. A team lead's job is extensive, sometimes good practices "fall through crack"; nevertheless team members and the organization will appreciate and benefit from the Lead's best effort.

## 5. References


1. Assessment of the Army Research Laboratory (US), National Academies of Sciences, Engineering, and Medicine. Washington (DC): The National Academies Press; ISBN 978-0-309-45436-0. 2015–2016. p. 129, 137. DOI: 10.17226/24653.
2. Wozniak S. Guest speaker at Augsburg College, scholarship weekend. Quote taken from the speaking engagement, as reported by Liz Sawyer in the Minneapolis Star Tribune, Sunday. 2017 Feb 19. p. B3.
3. Clarke TE. Management and leadership of scientists. 22nd Annual Conference of the Analytical Laboratory Managers' Association: Beyond Motivation to Engagement; League City, TX. tomeclarke.ca/artalma.htm, 2001 Oct. p. 10–14, 17.
4. Maslow AH. Motivation and personality. New York (NY): Harper and Row; 1954.
5. Jindal-Snape D, Snape JB. Motivation of scientists in a government research institute. 2006;44:1325–1343. www.emeraldinsight.com.
6. Perconti P. Strategic overview. Program formulation meeting, Aberdeen Proving Ground (MD): Army Research Laboratory (US); 2017 Mar.
7. Yuhas D. Three critical elements sustain motivation. Scientific American Mind. 2012 Nov;23(5).
8. KaiNexus. The definitive guide to the leadership behaviors that create a culture of continuous improvement. KaiNexus eBook Collection. [accessed 2017 Mar 2]. www.kainexus.com. 2015 Jun.
9. Croy K. Great leaders respond timely. n.d. [accessed 2017 Mar 2]. http://kellycroy.com/?s=Great+leaders+respond+timely.
10. Baines P. What it really means to respond in a timely manner. c2014 Oct. [accessed 2017 Mar 3]. http://vfcoaching.net/what-it-really-means-to-respond-in-a-timely-manner/.
11. Eurich T. The hidden costs of ignoring email. Irvine (CA): Entrepreneur n.d. [accessed 2017 Mar 6]. http://finance.yahoo.com/news/hidden-costs-ignoring-email-154500858.html.

12. Grant AM. Motivating creativity at work: the necessity of others is the mother of invention. American Psychological Association, Psychological Science Agenda, 2011 Jul [accessed 2017 Mar 31]. http://www.apa.org/science /about/psa/2011/07/motivating-creativity.aspx.

13. Phillips K. Making the transition from bench scientist to lab leader. The Scientist, 1991 Apr. [accessed 2017 Apr 3]. http://www.the-scientist.com /?articles.view/articleNo/11763/.

14. Public Affairs Office. US Army Research Laboratory Research Management & Leadership Strategy. Aberdeen Proving Ground (MD): Army Research Laboratory (US); 2015 Jun. p. 8–9.

## List of Symbols, Abbreviations, and Acronyms

| | |
|---|---|
| ARL | US Army Research Laboratory |
| BLUF | bottom-line upfront |
| DOD | Department of Defense |
| PM | Program Management |
| RDEC | Research Development and Engineering Center |
| SoA | state-of-art |
| SOW/E | Scope of Work/Expertise |
| TRADOC | US Army Training and Doctrine Command |

1 (PDF) DEFENSE TECHNICAL INFORMATION CTR
DTIC OCA

2 (PDF) DIRECTOR
US ARMY RESEARCH LAB
RDRL CIO L
IMAL HRA MAIL & RECORDS MGMT

1 (PDF) GOVT PRINTG OFC
A MALHOTRA

1 (PDF) TRANSFORMATION STRATEGIES, INC.
B DEVLIN

26 (5 HC, 21 PDF) DIR USARL
RDRL D
A KOTT
M HARPER
C LANE
T ROSENBERGER
RDRL LOH
D DIGGS
N SIMON
RDRL SL
P BAKER
RDRL VT
B SADLER
K MORGAN
E RIGAS
RDRL VTM
J RIDDICK
M BUNDY (1 PDF, 5 HC)
RDRL VTP
A GHOSHAL
RDRL VTS
H RUSSELL
RDRL WM
B FORCH
S KARNA
W WINNER
J ZABINSKI
RDRL WMP
D LYON
RDRL HRF
K OIE
RDRL SER L
B PIEKARSKI